Consolidated Space Operations Contract

DATE: April 9, 2003

TO: Distribution

FROM: AS&T/Information Data Management

SUBJECT: DCN 001 to WDISC Operations Concept

Attached is DCN 001 to the WDISC Operations Concept document. This DCN is a result of system enhancements pertaining to automated scheduling of the WDISC system and expansion of the PTP boards. Discard the current Operations Concept document and replace with the attached.

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LOCKHEED MARTIN

CSOC-GSFC-OC-002091
Original
(Supersedes 451-WDISC-ODC 98)

Consolidated Space Operations Contract

WSC Transmission Control Protocol (TCP)/Internet Protocol (IP) Data Interface Service Capability (WDISC) Operations Concept

August 17, 2001

Effective: August 17, 2001

Contract NAS9-98100

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This document supersedes WSC Transmission Control Protocol (TCP)/Internet Protocol (IP) Data Interface Service Capability (WDISC) Operations Concept, 451-WDISC-OCD 98, December 1998. Dispose of superseded documents in accordance with CSOC-CEN-SOP-000205.

Change Information Page

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Page Number	**Version**	**Nature of Change**
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DCN Control Sheet

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001	Printed	04/03	Cip, preface, toc, 1, 2, 3, 4, Appendix A, Appendix B	SL

Preface

This document specifies the Operations Concept of the White Sands Complex (WSC) Transmission Control Protocol (TCP)/Internet Protocol (IP) Data Interface Service Capability (WDISC) that includes policy issues, structure and function of the WDISC, and principal operations.

This document was originally created under National Aeronautical and Space Administration (NASA) control. The WDISC system has been converted to Consolidated Space Operations Contract (CSOC) control and thus this document has been converted to CSOC control. This document was originally published in December 1998. Upon conversion, the document has retained most of its original content with the exception of an update to the list of WDISC customers and document reference list, both of which are in Section 1. Much of the document was updated in DCN 001 to reflect automated scheduling and PTP expansion.

This document is under configuration management of the Goddard Space Flight Center (GSFC) Network Control Center Miscellaneous Systems (NCCMS) Sustaining Engineering Review Board (SERB).

Proposed changes to this document must be submitted to the SERB along with supportive material justifying the proposed change.

Changes to this document will be made by Documentation Change Notice (DCN) or complete revision.

Comments or questions concerning this document and proposed changes shall be addressed to WDISC Sustaining Engineering:

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Section 1. Introduction

1.1 Purpose and Scope

The White Sands Complex (WSC) Transmission Control Protocol (TCP)/Internet Protocol (IP) Data Interface Service Capability (WDISC) supports customers who require TCP/IP access to the WSC for telemetry and command processing. Support is provided from the National Aeronautical and Space Administration (NASA) Integrated Services Network (NISN) Closed IP Operational Network (IONET), using a defined set of authorized addresses. The initial customer set included New Millennium Program Earth Orbiter-1 (NMP/EO-1), Far Ultraviolet Spectroscopy Explorer (FUSE), and Gravity Probe B Relativity (GP-B).

WDISC has supported or will support the following customers:

a. Far Ultraviolet Spectroscopy Explorer (FUSE).

b. Galaxy Evolution Explorer (GALEX).

c. Gravity Probe B (GP-B).

d. Landsat-7.

e. Long Duration Balloon (LDB).

f. New Millennium Program Earth Orbiter-1 (NMP/EO-1).

g. Thermosphere Ionosphere Mesosphere Energetic Dynamics (TIMED).

h. Ultra Long Duration Balloon (ULDB).

1.2 Objectives

The WDISC is intended to provide a common solution to the needs of TCP/IP customers. No mission unique equipment at WSC should be needed to provide these data services. The design should allow for enhancements in capabilities and capacity. In particular, the WDISC should be able to evolve as new standards, such as the Consultative Committee for Space Data Systems (CCSDS) Space Link Extension (SLE) services, are adopted.

1.3 Background and Context

1.3.1

The WSC currently processes telemetry and command streams using legacy interfaces based on Nascom 4800 bit block formats. The WSC operates at the bit level and provides data quality monitoring at the frame level. Higher level formats and protocols (such as CCSDS packet telemetry or telecommand) are passed along to the customer unchanged for all further higher-level processing.

1.3.2

In addition to providing TCP/IP access to WSC, the WDISC also handles some higher-level activities such as Reed-Solomon decoding of return service data (i.e., telemetry).

1.4 Overview

The remainder of this document is organized as follows. Section 2 considers policy issues, Section 3 defines the structure and function of the WDISC, and Section 4 describes the principal operations of the WDISC. Appendix B provides a set of high-level procedures for obtaining WDISC services.

1.5 References

The latest version of the following documents is applicable.

a. WSC Transmission Control Protocol (TCP)/Internet Protocol (IP) Data Interface Service Capability (WDISC) Project Management Plan (PMP), CSOC-GSFC-PLAN-002094.

b. WSC Transmission Control Protocol (TCP)/Internet Protocol (IP) Data Interface Service Capability (WDISC) System Requirements, CSOC-GSFC-RD-002090.

c. WSC Transmission Control Protocol (TCP)/Internet Protocol (IP) Data Interface Service Capability (WDISC) Service Specification, CSOC-GSFC-RD-002056.

d. Detailed Mission Requirements (DMR) Document for the Gravity Probe-B Mission (GP-B), 450-DMR-GP-B, Review Issue 5, May, 2001.

e. Detailed Mission Requirements (DMR) Document for the New Millennium Program Earth Orbiter-1 (NMP/EO-1), 450-215/EO-1.

f. Space Network (SN) Detailed Mission Requirements for the Far Ultraviolet Spectroscopic Explorer (FUSE), No Identifier.

g. EO-1 Spacecraft to Ground Interface Control Document, No Identifier.

h. Requirements Specification for the White Sands Complex (WSC), 530-RSD-WSC.

i. Space Network (SN) User's Guide, 530-SNUG.

j. PTP NT Programmable Telemetry Processor for Windows NT, User's Manual, Version 1.40, November 1998.

k. AVTEC PTP for Windows, Programmable Telemetry Processor User’s Guide, Version 1.49, July, 19, 2001.

l. NASA Communications (Nascom) Programmable Telemetry Processor (PTP) Installation and Troubleshooting Guide, No Identifier.

m. Interface Control Document (ICD) Between the Network Control Center (NCC)/Flight Dynamics Facility (FDF) and the White Sands Complex (WSC), 530-ICD-NCC-FDF/WSC.

n. Data Services Management Center System Requirements Specification, Rev D., DCN 001. August 2002, CSOC-CEN.SE11.001070.

Section 2. Management Policy

2.1 Constraints

The WDISC interfaces with WSC, the Network Control Center Data System (NCCDS), the Data Services Management Center (DSMC), as well as with the customer. The WDISC operates within the Data Interface System (DIS) element of the WSC and is controlled and configured by PCs located at WSC and the Network Integration Center (NIC). It requires minimal interaction with operational personnel.

2.2 Risks

Use of Commercial Off-the-Shelf (COTS) software with minimal custom development should limit the risks associated with the development of the WDISC. Operational risks are expected to be minimal.

Section 3. System Description

3.1 Functional Capabilities

The WDISC supports the following functional capabilities

a. Receive encapsulated forward service data from a customer Mission Operations Center (MOC) via the Closed or Open IONET, convert data to serial form, and present it to a WSC local interface (LI) port.

b. Receive serial return service data from a WSC LI port, encapsulate it, and transmit it to a customer MOC via the Closed IONET.

c. Data monitoring including computing CCSDS statistics for forward and return data processed.

d. Data recording.

e. Data playback.

f. Provide real-time status on forward and return service data processed for use at the NIC (GSFC), and/or WSC.

3.2 Reference Architecture

The reference architecture is shown in Figure 3-1, which has been adapted from document Reference a. It includes the Closed IONET, PTPs, and the MOC that may be connected to the Open or Closed IONet. The WDISC comprises eight PTP units, two sets of primary and backup PTP pairs at each of the WSC ground terminals – WSGT and STGT. Each PTP has three processing "boards." Each board can handle a single forward and a single return data stream for the same event, and any board can be used to fully support any of the initial customers. This provides additional redundancy. Appropriate switching and controls permit failover to occur between matching boards on the prime and backup PTP units.

NOTE

Two boards would be required to support dual data source customers (i.e., independent I and Q return data streams), or services scheduled in separate events.

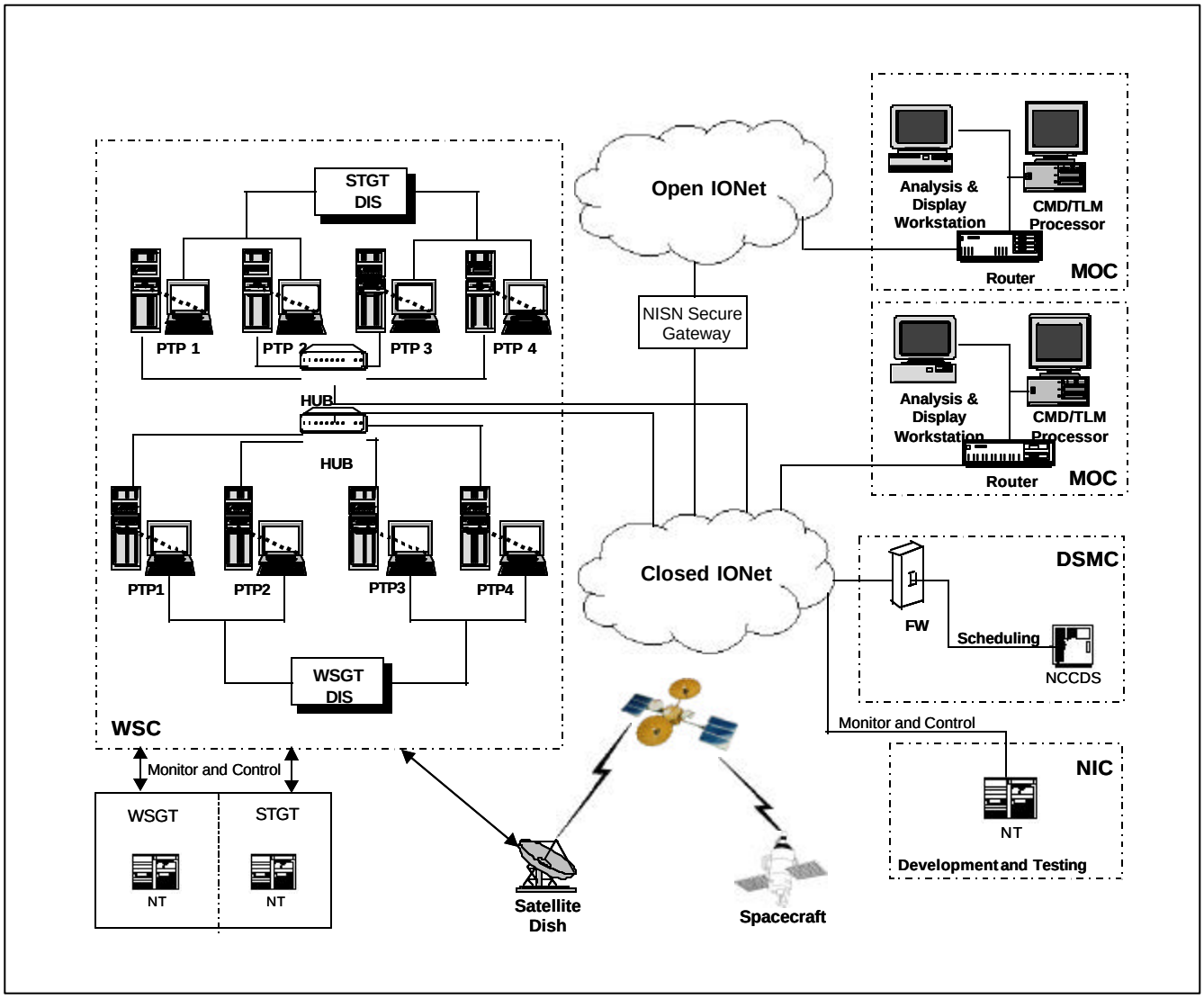

Figure 3-1. WDISC Reference Architecture

3.3 System Interfaces

3.3.1 Data Interfaces

The WDISC has the following data interfaces

a. TCP/IP interfaces with the customer for transport of forward and return data.

b. Serial interfaces with the LI port at the DIS.

c. TCP/IP interfaces with the customer via TBD.

3.3.2 Control Interfaces

The WDISC has the following control interfaces

a. TCP/IP interfaces with the NCCDS for schedule management.

b. TCP/IP interfaces with the WSC operator via COTS GUI for status reporting.

c. TCP/IP interfaces with the customer via socket-level transport for controlling configuration of forward data flows.

d. TCP/IP interfaces with the customer for reporting status of forward services (i.e., system heartbeat)

e. TCP/IP interfaces with the WSC operator via COTS GUI for controlling the configuration of forward data flows, status reporting, maintenance of configuration files, and controlling the configuration of forward data flows.

3.4 Future System Extensions

A proposed enhanced version of the WDISC is planned to interface automatically with the NCCDS to provide status information. This would eliminate the need for routine operator activity to monitor WDISC performance. At this time two options are under consideration.

Section 4. System Operation

4.1 Operational Requirements

The WDISC is capable of being remotely operated by NIC personnel. Local operation is also possible if necessary. Limited actions are needed for nominal operation.

a. Review of the NCCDS schedule and transmission status of "PTP events" based on information contained in the NCCDS database and schedule.

b. Initial entry of "desktop" files, which define the nominal configurations of the PTP required by each customer.

c. Occasional maintenance of "desktop" files.

d. Failover activities if a failure condition occurs.

e. Maintenance of hardware and software configuration of the PTP.

4.2 Operational Scenarios

4.2.1 Scheduling and Configuration of the PTPs

4.2.1.1 Requesting PTP Resources

a. The MOC requests SN services by submitting standard Schedule Add Request (SAR) messages to the DSMC. As appropriate, the WSC Scheduler may instead enter SARs based on voice, fax, or e-mail input from the MOC. The SAR requests WDISC services by referencing an SSC that specifies a WDISC UIFC.

b. The WSC provides its support based on the scheduling orders (SHOs) sent from the NCCDS. The MOC is notified of support via a User Schedule Message (USM) sent by the NCCDS or by voice, fax, or e-mail , as appropriate. The WDISC provides its support based on the information contained in the PTP Event Command message sent from the NCCDS.

c. The MOC may delete a scheduled event by submitting a standard Schedule Delete Request (SDR). The NCCDS will notify the MOC of this action via a Schedule Result Message (SRM). The NCCDS will also notify the WSC and the WDISC that the schedule event has been deleted through their respective event cancel messages.

4.2.1.2 Transmission of Schedule Message to PTPs

a. The WSC Scheduler / Database operator defines a transmission rule set(s) that sends PTP messages to the PTP daily for each event that requires WDISC support. For each event, the PTP Event Command message specifies the appropriate desktop(s) and the start and stop times of the PTP support. This is

all the scheduling information needed for the PTP to correctly process and transport data between the MOC and the LI at WSC.

b. The scheduling messages are transmitted to each member (i.e., the prime and backup) of the applicable PTP set at WSC and received by the PTP timer server (i.e., software process) that is associated with the specified board. The information is stored there and used to setup, start, and stop the PTP as specified. Feedback, via an automatic response from the PTP, is returned to permit the WSC operator to view the status of the schedule transmission.

4.2.1.3 Selection of Desktop for Service

As indicated above, all of the information to configure the PTP to support commanding and telemetry services on a single board is contained within the "desktop." In order to provide as much flexibility as possible, the selection of the desktop is implicitly determined by several components of the scheduled service. Specifically, the selection of the appropriate desktop is based upon the unique combination of Support Identifier (SUPIDEN), forward User Interface Channel ID (UIFC) and data rate, return UIFC and data rate, and data flow direction.

4.2.1.3.1 Support Identifier (SUPIDEN)

Because the WDISC provides TCP/IP communications, the desktop must specify a specific transport address to establish the necessary service connection. MOCs may want to use multiple machines (e.g., have a backup machine) to send / receive data. This flexibility is provided through a SUPIDEN naming scheme in which a unique transport address is associated with each SUPIDEN.

4.2.1.3.2 User Interface Channels

Each PTP board is connected to a specific forward LI port and a specific return LI port of the DIS at each ground terminal. The NCCDS manages the allocation of the PTP board through the pair of WDISC UIFCs (one forward, one return) mapped to the LI ports. Because a distinct "desktop" can be associated with each board, the scheduled UIFCs are one component that determines the desktop selection.

4.2.1.3.3 Data Rates

a. For forward services, the PTP board converts TCP/IP encapsulated data to serial form. To do this, the desktop must specify a specific forward data rate from which to generate the serial clock. Therefore, the data rate specified within the forward service SSC is a component used to select the correct desktop.

b. For return services, the PTP board encapsulates serial data into TCP/IP data streams and sends it back to the MOC. Although not used currently, future enhancements to the desktop modules may require that a return data rate be specified within a desktop. To facilitate this potential enhancement, the data rate specified within by return data stream is a component used to select the correct desktop.

4.2.1.3.4 Data Flow Direction

For each board, WDISC support can be for one of the following data flows: forward only, return only, both forward and return. Forward only (and return-only) support does not preclude a desktop from containing both forward and return service modules. However, creating ”one way” desktops is possible and, therefore, is addressed within the desktop selection scheme. Return UIFC and data rate are null for forward-only services and vice versa.

4.2.2 Initial Loading of PTP Configuration Information

The PTP "desktops" and any other mission-related information are developed and loaded into each PTP prior to testing with a new Project or customer.

4.2.3 Maintenance of PTP Configuration Information

A PTP Configuration Maintenance (CM) unit, either a fully configured PTP or a standard Windows NT box, is located in the NIC computer room or other work area. The DSMC Data Base Administrator (DBA) or system administrator updates PTP configurations at WSC by logging on from the PTP CM unit. COTS software is used to access and modify the PTP "desktops" and other files. It is assumed that "desktops" defined at the beginning of a customer mission generally require no changes throughout the mission. It will be necessary to update each of the PTPs individually working from a master version on the CM unit.

NOTE

As new customers come on-line, the developers responsible for initial "desktop" development (refer to paragraph 4.2.2) will create new “desktops” to meet new requirements. The new desktops will be maintained as stated above. At a later time, responsibility for “desktop” maintenance may transfer to WSC.

4.2.4 Obtaining Real-time Status from the PTPs

The NOM at the NIC, WSC Operations Supervisor (OS) or other WSC operator may access current status information from the PTP by logging on to the PTP from the Windows NT machine. PTP status will include the number of frames processed, the number of errors, and other statistics.

The WSC operator may also access the same information from a Windows NT box located in the TDRSS Operations Control Center (TOCC). If a failure condition is noted, the TOCC operator may participate in fault isolation and recovery assistance.

4.2.5 PTP Failover

Redundant PTP equipment is provided and any failovers will be handled manually by the WSC operator upon notification by the customer MOC. For Closed IONet customers, the PTP acts as either the server or client; for Open IONet customers, the PTP acts as the client. Appendix B and document Reference c provide additional detail. WSC personnel are responsible for correcting a failed PTP (e.g., by rebooting it).

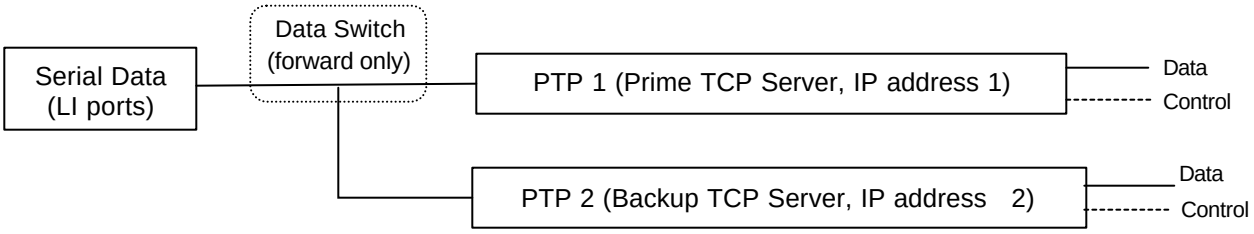

Figure 4-1. Redundancy and Failover

4.2.5.1 Return Data

a. As shown in Figure 4-1, both PTPs receive return data from the return LI port. The PTPs are configured with the same "desktop." First, if the MOC is on the Closed IONet and the PTPs are acting as servers, the client attempts to connect to PTP 1 (primary PTP). If the connection fails or if the client cannot read any data for a specified time-out period, then the client attempts to connect to PTP 2 (backup PTP). Appendix B indicates how the MOC might detect and react to a failure while a return service is in progress.

NOTE

The MOC may connect to both PTPs and receive two return data flows if sufficient bandwidth is available.

b. If the MOC is on the Open IONet, or the PTPs are acting as clients, PTP 1 and PTP 2 attempt to connect to the MOC server. If a connection fails, the MOC has the option of switching to the other data stream.

4.2.5.2 Forward Data

A data switch is provided to switch forward data from either the primary or backup PTP to the forward LI port. There are three switches at each ground terminal, corresponding to the three boards in the primary or backup PTP. The MOC or PTPs establish forward

data and control port connections. The MOC uses the control port to send a control character string designating the primary PTP (see Figure 4-1). The PTP then configures the data switch based on that control character string. If a failure occurs, the MOC sends new control information to the backup PTP (i.e., the control character string designating the backup PTP). The backup PTP then reconfigures the data switch and the flow of forward data can continue. Appendix B indicates how the MOC might detect and react to a failure while a forward service is in progress.

NOTE

The data switch permits forward data flow either from the primary or backup PTP, never both. Configuring the switch from the primary PTP enables forward data flow to the primary and disables flow to the backup, and vice versa.

NOTE

In a contingency, the WSC operator may also control the configuration of the forward data switch using the access described in paragraph 4.2.4.

4.2.6 Management of PTP Configuration

4.2.6.1 Hardware Maintenance

The WSC maintenance and operations staff provides any maintenance of the PTP platform as necessary. Failed units will be returned to the vendor for repair. A spare PTP is available during the repair period for redundancy. Diagnostics and loop back capabilities are included in the COTS product.

4.2.6.2 Software and Data Management

Configuration management personnel at WSC update the PTP software releases using existing WSC configuration management procedures. All data configuration management is provided as described in paragraph 4.2.3.

Appendix A. Abbreviations and Acronyms

Acronym	Definition
AOS	acquisition of signal
CCSDS	Consultative Committee for Space Data Systems
CM	configuration management
COTS	commercial off-the-shelf
CSOC	Consolidated Space Operations Contract
DBA	Data Base Administrator
DCN	Documentation Change Notice
DSMC	Data Services Management Center
DIS	Data Interface System
EO-1	Earth Orbiter-1
FTP	File Transfer Protocol
FUSE	Far Ultraviolet Spectroscopy Explorer
FW	Firewall
GP-B	Gravity Probe B
GSFC	Goddard Space Flight Center
GUI	graphical user interface
IONET	IP Operational Network
ICD	Interface Control Document
IP	Internet Protocol
LI	Local interface
MOC	Mission Operations Center
NASA	National Aeronautics and Space Administration
NCC	Network Control Center
NCCDS	Network Control Center Data System
NCCMS	Network Control Center Miscellaneous Systems
NIC	Network Integration Center
NISN	NASA Integrated Services Network
NMP	New Millennium Program

Acronym	Definition
OCR	Operations Control Room
OET	Operational Evaluation Testing
PTP	Programmable Telemetry Processor
SAR	schedule add request
SERB	Sustaining Engineering Review Board
SHO	scheduling order
SIC	support identification code
SLE	space link extension
SN	Space Network
SPSR	Service Planning Segment Replacement
SSC	Service Specification Code
STGT	Second TDRSS Ground Terminal
SUPIDEN	Support Identifier
T&T	Test and Training
TCP	Transmission Control Protocol
TDRSS	Tracking and Data Relay Satellite System
TOCC	TDRSS Operations Control Center
UIFC	user interface channel ID
USM	User Schedule message
WDISC	WSC TCP/IP Data Interface Service Capability
WSC	White Sands Complex
WSGT	White Sands Ground Terminal

Appendix B. Procedure for Obtaining Data Services

B.1 Timeframe

In the following procedures, the scheduled service start time is denoted as "T." Acquisition of signal (AOS) and data flow typically begin a few seconds after time T (see document Reference i for a better estimate).

B.2 Pre-Service Activities

a. (approximately T - 2 weeks) Customer requests service for each support period within a 7 day time span by submitting a separate SAR to the NCCDS or by providing other input by voice, fax, or e-mail. For each service to be provided, the SAR references a Service Specification Code (SSC) maintained in the NCCDS database. The SSC contains the detailed information necessary to schedule and configure an SN service. This includes a complete list of UIFCs valid for the service. Within the NCCDS database, each WDISC UIFC is mapped either a WSGT or STGT LI port.

NOTE

The support period corresponds to a single event on a specific TDRS providing one or more services. The procedures used to request these events are beyond the scope of this document (i.e., limited to PTP actions). Reference i provides a full description of this process.

b. (approximately T - 1 week) Customer receives confirmation for each scheduled event via a USM or other notification. Notification indicates which WDISC UIFC is scheduled for each data channel. Distinct UIFCs will be used for each ground terminal. The customer can then use the UIFC to identify the correct domain name (i.e., IP address) for the prime and backup PTP at the scheduled ground terminal.

c. No planning activities may be possible in a contingency or emergency situation. All PTP support will be coordinated in real time.

B.3 Return Service

a. (T - 5 second) A TCP/IP connection (socket) is opened between the customer and the prime PTP using the mission-specific data port assigned to that customer and, optionally, a connection is opened between the customer and the backup PTP.

b. (AOS through end of support period) Customer receives telemetry under CCSDS protocols. The presence of telemetry confirms the proper functioning of the return service. The connection remains active for 3 seconds after the service stop time to deliver the final frames of data.

c. (Post event) When playback is required, customer determines TBD.

d. (contingency: fault with the prime PTP) Customer fails to receive return data from the prime PTP. Customer informs the WSC operator via voice for assistance in fault isolation. The WSC operator also participates in this activity.

   1. Customer connects to backup PTP if not already connected (refer to step a).

   2. Customer receives telemetry from backup PTP (refer to step c).

B.4 Forward Service

a. (T - 5 seconds) A TCP/IP connection (socket) is opened between the customer and the prime PTP using the mission-specific data port assigned to that customer and, optionally a connection is opened between the customer and the backup PTP.

b. (T - 5 seconds) A TCP/IP connection (socket) is opened between the customer and the prime PTP using the mission-specific control port assigned to that customer and, optionally a connection is opened between the customer and the backup PTP.

c. (T - 5 seconds or later) Customer configures the forward data switch by transmitting to the control port via a socket connection the control character string designated for the prime PTP.

d. (AOS through end of support period) Customer waits a delay period to permit an idle pattern to be established, as required by CCSDS or other specifications. Customer transmits command data as needed.

e. (AOS through end of support period) Customer accesses the control port for the selected PTP board on the prime PTP and receives status (i.e., system heartbeat) confirming that the PTP is actively providing forward service.

f. (contingency: fault with the prime PTP) Customer fails to receive system heartbeat and cannot transmit forward data using the prime PTP. Customer informs the WSC operator via voice for assistance in fault isolation. The WSC operator also participates in this activity.

   1. Customer connects to the data port on the backup PTP if not already connected (refer to step a).

   2. Customer connects to the control port on the backup PTP if not already connected (refer to step b).

   3. WSC operator configures the forward data switch by transmitting on the control port on the backup PTP, a control character string designated for the backup PTP.

   4. Customer receives service from the backup PTP (refer to step c).

5. Customer waits the required delay time to permit the idle pattern to be established. Customer transmits command data as needed (refer to step d).

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Original